Breastfeeding Patterns among Tropical Horticulturalists in the Brazilian Amazon

A Senior Honors Thesis

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by
Lindsey Gooden

The Ohio State University
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Project Advisor: Professor Barbara Piperata, Department of Anthropology

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Introduction

It is well recognized that breastfeeding is important for infant growth and development. According to the World Health Organization (2008) breast milk provides infants with energy and nutrients, protection against infectious and chronic diseases, and promotes sensory and cognitive development. Breastfeeding also helps with birth spacing due to its relationship with postpartum amenorrhea (Howie, 1991; McNeilly, 1993), allowing women time to recuperate between reproductive events (Vitzthum, 1994), and has also been shown to be protective against certain types of reproductive cancers (Nuñez de la Mora and Bentley, 2008).

While breastfeeding has been shown to have positive health effects for both infants and mothers, breast milk production and infant feeding are costly in terms of both energy and time. The production of breast milk increases a woman's energy needs by 25-30% (500-700 additional kcal/day) (Dewey, 1997). It also requires additional time on the part of the mother which she must balance with her other commitments. Therefore, the benefits of breastfeeding to the infant must be balanced with the costs to the mother. This is especially the case in rural settings where women often play a significant role in food production and thus must accommodate their roles as both producers and reproducers. While many studies report data on the effect of maternal work schedules on breastfeeding duration, only a small number (Gray, 1995; Marriott, 1998; Panter-Brick, 1994; Vitzthum, 1989) have included detailed data on what Vitzthum (1994) refers to as *breastfeeding structure*. Breastfeeding structure is the temporal patterning of suckling frequency (number of bouts), suckling duration (bout length), and the interval duration (interval between bouts) (Vitzthum, 1994). An understanding of breastfeeding structure and the influence of maternal work patterns on it is important since it is argued that variation in the structure of breastfeeding explains variation in the period of postpartum amenorrhea observed between, as

well as among human populations (Vitzthum, 2001). To date there are only a few studies that have documented the breastfeeding structure of rural women in subsistence-based economies (Gray, 1995; Marriott, 1998; Vitzthum, 1989) limiting our understanding of the variation that exists between human populations in different cultural and ecological contexts.

Brown (1970) suggested that the type of subsistence work females perform is dependent on the compatibility of the work with childcare. According to Brown (1970), for subsistence work to be compatible with infant care, the work needs to have certain characteristics, including: the ability to perform the work close to the home, repetitive tasks, tasks that are interruptible, and tasks that are not dangerous. Nerlove (1974) added to Brown's ideas by suggesting that while women's work may often follow the characteristics described by Brown (1970), women who play a large role in subsistence activities "simply have less available time and energy" to care for their infants. She went on to suggest that breastfeeding is especially disruptive of subsistence work as it can require the mother to stop what she was doing and allow to infant to feed. While others can aid the mother with the infant care, the infant can rarely receive substitute care for breastfeeding. Nerlove (1974) found that mothers who began supplementary feeding before one month contributed more time to subsistence activities than mothers that began supplementary feeding after one month.

Panter-Brick (1994) examined child nutrition and women's work in two different castes in Nepal during different seasons. The first group, the Tamang, are agropastoralists whose subsistence work varied seasonally. The second group, the Kami, are blacksmiths who had lower levels of subsistence work and spent more time at home. Panter-Brick (1994) found that among the Tamang, the interval between bouts increased with the child's age. Among the Kami, the interval between bouts did not vary with the child's age. Panter-Brick (1994) hypothesized that

because these women spent more time at home with their children and gave them more supplementary meals during the day, the breastfeeding intervals were more irregular due to the mixed diet.

Other studies have also attempted to determine the effects of maternal work on breastfeeding and infant care. Quandt (1998) noted that studies in the United States failed to come to a conclusion about the effect maternal work had on breastfeeding, with different studies producing opposite results. While some studies showed that women who worked outside the home breastfed less and for shorter amounts of time, other studies showed the opposite. This could potentially be due to differing definitions of the elements of breastfeeding structure that make them incomparable. Bamji and Thimayamma (2000) also found this to be true in India when examining child nutrition and maternal work load, different studies produced conflicting results. Some studies found that the mother's work outside the home had a negative effect on child nutrition, while another study found that mother's work outside the home had no effect.

Gray (1995) in her work among Turkana pastoralists examined factors influencing breastfeeding. Gray (1995) examined environmental, socioeconomic, and bio-behavioral factors to determine their influence on breastfeeding frequency such as rainfall frequency, resource distribution, social network and human resources, size of the herd, maternal activity patterns, infant care practices, mother's and infant's age, mother's parity, and nutritional status. Gray (1995) found that the environmental, socioeconomic, and bio-behavioral factors affecting a mother's ability to participate in herding and other activities away from the camp, such as social support and maternal physical status, showed significant correlations with breastfeeding frequency (number of bouts).

Marriott (1998) noted that many studies have examined weaning practices and also the benefits and costs of breastfeeding for the infant and mother. However, there is a "fundamental gap in knowledge of breastfeeding structure…and its determinants." Therefore, Marriott examined possible ecological and behavioral determinants of breastfeeding structure among the agro-fishing Bozo and pastoral Fulbe in Mali. She examined the variation in breastfeeding structure based on the time of day and on the age of the infant. Marriott found that suckling patterns did not vary based on the time of day, although there was much individual variation. She also found that the age of the infant was negatively correlated with breastfeeding session duration (bout length).

Vitzthum (1994) also examined breastfeeding structure. She noted that women with similar breastfeeding magnitude showed high variation in post-partum amenorrhea. For example, women who practiced exclusive breastfeeding still showed much variation in post-partum amenorrhea. She also noted the lack of data regarding breastfeeding structure. She noted that examining the different factors influencing breastfeeding structure could lead to an explanation for the variation in post-partum amenorrhea. She also discussed the importance of defining the different aspects of breastfeeding structure and examining behavioral, cultural, and environmental factors may improve studies in this area.

While the challenge to look beyond breastfeeding duration and examine breastfeeding structure has been met by a few researchers (Gray, 1995; Marriott 1998; Panter-Brick, 1994; Vitzthum 1994), there are still very few studies within a limited range of cultural and ecological settings. Tropical horticultural women in numerous Amazonian populations make significant contributions to household subsistence work (Dufour 1984; Piperata, 2005), yet, to date, no

studies have examined breastfeeding structure and its interaction with maternal work patterns among these groups.

Piperata (2005), in a longitudinal study of lactational energetics, collected detailed data on the breastfeeding structure of a group of tropical horticultural women living in rural communities in the eastern Amazon. Women in these communities make a substantial contribution to subsistence work and household food production. Therefore, the purpose of this research is two-fold: first, to describe the breastfeeding structure of a group of these rural horticultural women and second, to determine if subsistence work influences breastfeeding and infant care in this setting. In this study, I will address the following questions:

1. What is the breastfeeding structure (number of bouts, bout length and inter-bout interval) and how does it change over time?

H1: Breastfeeding structure will change over time. Specifically, I expect the number of bouts and length of bouts to decline over time and the interval between bouts to increase as lactation progresses.

2. Did women's participation in subsistence work affect their breastfeeding patterns and infant care?

H2: Time in subsistence work is negatively correlated with time spent breastfeeding and caring for the infant.

Background and Subjects

The study population includes seven, upper-land (*terra firme*) communities in and around the Caxiuanã National Forest in the Brazilian State of Pará. The women included in this study

self-identified as *Ribeirinhas* (river people) and are of mixed ancestry (Native Amazonian, Portuguese, African). The people in the seven communities spoke Portuguese, practiced one of two Christian religions (Catholic or Evangelical), lived in primarily nuclear households, observed Brazilian and Christian holidays, and identified with the larger Brazilian culture.

FIGURE 1. Map showing the location of the field site

Source: Central Intelligence Agency, 1994

These communities were located about 8-10 hours by small, motorized boat away from the nearest town, Portel, that has a population of approximately 45,500 (IBGE, 2009). None of the communities had running water or electricity. The region is ecologically classified as humid tropics (Lisboa, 2002). The rivers in this region are black-water and have a fairly stable pH (4.7), although the influence of Caxiuanã Bay causes variability in clarity and pH in the rivers that form the border of this region (Costa et al., 2002). The average temperature was 26.7° C and tended to fluctuate more diurnally than annually. The average rainfall was about 2,060 mm per year. The region has a wet season (*inverno* or winter, January through May) and a dry season (*veraõ* or summer, June through November). More than 70% of all precipitation occurs during the wet season, while the dry season has higher temperatures.

Subsistence Activities

The people in these seven communities were subsistence farmers and practiced slash and burn agriculture in the upper-land forests (*terra firme*). Bitter manioc (*Manihot esculenta* Crantz*),* primarily consumed in the form of *farinha*, a toasted meal, was the dietary staple and most families had at least one manioc garden (*roça*). The starch was also extracted and used to make tapioca and *beiju* (a pancake-like bread). Most families had a small herb garden near the home and some also planted other fruits and vegetables, such as bananas, watermelon, pineapple, corn, beans, squash, and sugar cane, in their gardens. Several fruiting trees were also managed with *açai* (*Euterpe oleracea*), consumed mainly in the form of a juice, being the most important in the diet. Fishing was typically done every day and supplied most of the dietary protein. Hunting, usually with shotguns and dogs, provided additional sources of protein.

While men did almost all of the hunting and fishing, much of the subsistence work was shared between men and women such as the work associated with the cultivation, harvest and processing of manioc. The only aspect of manioc cultivation that was done almost exclusively by men was the clearing of the forest plot where the garden was planted. Once cleared, both men and women, and even children, planted the manioc stems (*maniva*). Both men and women did the gardening work including weeding, the collection and transportation of the manioc roots, and all stages of *farinha* processing.

It typically took three days to process the manioc into *farinha*. After the roots were collected from the garden on the first day, they were transported to the river where they would soak in a sunken canoe for approximately two days. Once the roots were deemed soft enough, a second garden trip was made to collect an equivalent number of fresh (dry) roots. The wet and dry roots were transported back to the manioc-processing house (*casa do forno*) and peeled. The dry, peeled roots were then grated using a spinning grater that was powered by people spinning a large wheel (*roda*) or peddling a bicycle. Once the dry roots were grated they were mixed (kneaded) with the wet roots, now referred to as the *massa*. This mixture was then transferred into perforated sacks or a specialized (*tipiti*) basket in order to expel the water (~20 minutes). This dried fiber (*massa*) was then sifted through specially made baskets and then slowly toasted over an open griddle until the majority of the water was removed and the material had a dry, crunchy texture (now referred to as *farinha*).

The division of labor meant that women spent most of their time in and around the household while men were typically further away. It was very common for men to help women transport manioc from the garden to the *casa do forno* to be processed and then leave the women to process the *farinha* while the men fished and/or hunted. While men typically fished, hunted

and collected *açai*, the women prepared the fish and game meat and extracted the *açai* juice. The few wage labor jobs available in the area were held by men. These included small-scale timber extraction and work at the Ferreira Penna Research Station, located close to one of the communities. Women maintained the household. They almost exclusively did the cooking, cleaning and clothes and dish washing. Women were also responsible for childcare and hauling water (for cooking and drinking) from the river or wells.

All of the families participated in the market economy through the trade of *farinha*, *açai* and, to a lesser extent, Brazil nuts. Most people relied on merchant boats (*regatão*) to sell/trade these products for industrialized goods due to the remoteness of the region. The *regatão* acted as the middle man, buying the agricultural products and selling the residents industrialized goods. These included sugar, coffee, cooking oil, beans, rice, dried and salted beef, soap, gas, clothing, matches, pots, tools, and building materials. Some of the residents owned their own motorized boat, or had access to a community one. This enabled them to make periodic trips to Portel to trade/sell their agricultural products either directly to merchants or the public. While this eliminated the need for the *regatão* (middleman), it required access to a boat and direct sale to the public was much more time consuming. Men were primarily responsible for negotiating the sale of *farinha*, but once the price was agreed upon, women used the credit to purchase goods.

Breastfeeding and Infant Care Practices

Infants were breastfed on demand and slept with their mothers in a hammock at night so they could breastfeed. Infants almost always initiated breastfeeding by either crying or actively seeking the breast. The observation was made that women working in their gardens briefly breastfeed and then would take the still awakened infant off the breast and hand it to an older

sibling and return to work. However, if the infant resisted and cried, the woman would often allow the infant to continue to breastfeed. Most women agreed that male babies were more demanding in terms of breastfeeding than female babies.

Cultural beliefs regarding the appropriate time to introduce supplemental foods and the types of foods that could be fed to an infant were important in determining breastfeeding duration. Women usually said that they intended to exclusively breastfeed their infant for at least six months and most said that weaning should take place when the baby was one year old. The concept of exclusively breastfeeding for six months comes from the dissemination of western medical advice obtained by those few women who actually saw a doctor during pregnancy or lactation, however it was rarely followed and most women began supplementing much earlier.

Breastfeeding duration was determined by both biological and cultural factors in these *Ribeirinho* communities. The major biological factor that determined the duration of breastfeeding was the recognition of a new pregnancy and the most common answer to the question "why did you wean that child" was the realization of a new pregnancy. It was very common for women to be breastfeeding during the first trimester of pregnancy since they were often unaware they were pregnant again. Many women reported getting pregnant while still breastfeeding and some had never resumed menstruating.

Mother's spent a lot of time caring for their children, especially infants. Infants were constantly in someone's arms and were passed from one person to another all day long. They were only left alone when they slept during the day in a hammock and even then it was common for either their mother or one of their siblings to join them. Older siblings (especially girls) and other women (grandmothers, aunts, etc.) would often help with infant care. They would help the

mother by holding the infant or feeding it supplemental foods such as gruels made of manioc, rice or corn flour, water, sugar, and, when available, powered milk.

METHODS

Study Design

The data included in this paper were collected by Dr. Barbara Piperata (researcher) between 2002-2004. The research protocol was approved by the University of Colorado's Human Research Committee (HRC no. 1001.2) and the Comite de Ética at the University of São Paulo in Brazil. The study focused on a sample of 23 lactating women who were followed from early lactation until ~16 months postpartum. Women were recruited for the study during the latter stages of pregnancy. All pregnant women (2nd to 3rd trimester) living within a one-hour (by motor boat) radius of the Estação Científica Ferreira Penna (ECFPn) (Ferreira Penna Scientific Station), located in the Caxiuanã National Forest, were invited to join the study. Participation was voluntary. Both the individual women and their communities were compensated for participation. Individual women received small gifts (pressure cookers, glassware, dishes, fishing nets) and communities received assistance with the installation of manual pumps for their hand-dug water wells and books for their schools.

The mother/infant pairs were observed for three consecutive days in each of three measurement rounds. The first measurement round occurred during *resguardo,* a culturally defined period (first 40-41 days postpartum). During *resguardo*, the women were considered especially vulnerable and observed a series of food taboos and work restrictions. The food taboos generally included the avoidance of fatty foods, including some fish and fruits, and foods that were the color red (Piperata, 2008). The activity restrictions included the avoidance of

strenuous tasks such as those associated with subsistence work (Piperata, 2008). Women also avoided entering the forest and river during the restricted period. Other female relatives or the husband would often help with household chores and childcare during this time.

The second measurement round, referred to as peak lactation (2-4 months), is the time when infants place the greatest energetic burden on their mothers due to more intense breastfeeding (Prentice et al., 1996). Most of the women had not yet initiated supplemental feeding at this time. The third measurement round is referred to as late lactation (12-14 months) and was close to the time when the women in the area weaned their children.

Data Collection

In each of the three measurement rounds, detailed data on breastfeeding practices and maternal time allocation were collected. The researcher, who remained in visual contact with the women over the entire period of time, arrived at the home between 7:30 and 8:00 AM and left after dinner, typically between 5:30 and 6:30 PM. From the 23 women that were observed, a core group of 17 women, for which detailed data on breastfeeding practices were collected in all three measurement rounds, are included in this study. The age of the women ranged from 15 to 42 years of age. In order to control for variation in the observed periods, only observed activities that started no earlier than 8AM and no later than 5PM are included in data analysis.

Maternal Time Allocation

Maternal time allocation data were collected using continuous activity diaries. Each activity the women engaged in was given a numeric code for a total of 96 different codes. The diaries included the start and end time of each activity the woman conducted (primary and

secondary), as well as her body position (laying, sitting, standing). In this paper I focus on the activities related to breastfeeding, infant care, and subsistence work (including gardening or processing manioc). Table 1 lists the activities included in each of these categories. Time spent in each activity category was calculated by adding up the time spent in each activity within the category over the course of the day. In the case of breastfeeding, a stop-watch was used to measure the duration of each breastfeeding bout (time infant latched onto breast to time their mouth came off the breast) to the nearest second. Total time spent breastfeeding per day was then calculated by adding together the duration of all bouts. The total time (minutes) spent caring for the infant (excludes breastfeeding) was calculated by adding together the time each woman spent in each of the infant care activities listed in Table 1. From these daily totals, an average for each woman was calculated in each of the three rounds. The group mean was calculated from these individual averages. Percent time in the different activity categories were calculated by dividing the total time in that category by the total observed period (8AM -5PM, total of 540 minutes).

Activities related to gardening and manioc processing were categorized as subsistence work (Table 1) and are considered separately, as well as combined in order to calculate: (1) the total time women spent in subsistence work, (2) the total time spent in garden work which took place far from the home, and (3) the total time spent in food processing (manioc and *açai*) which took place close to the home. Subsistence work was broken into these two categories to examine Brown's (1970) hypothesis that women will be more likely to engage in subsistence activities that are compatible with childcare, and therefore often close to the home, interruptible, repetitive, and not dangerous. The processing huts are located next to or close to the homes and are generally a safe environment, while the gardens are farther away from the homes and, according

to the people in the communities, considered more dangerous for the infants. Processing manioc was repetitive and most of the steps were easily interruptible.

The total time spent in subsistence activities (combines and separated, garden and processing) was calculated by adding together the elapsed times for the activities coded as subsistence work.

TABLE 1. Selected activities recorded in the activity diaries

Recorded Activities
Subsistence Activities
Manioc Processing/Close to the house
carrying heavy over 5 kg
tie up wood/fronds etc
making baskets
peeling manioc
feed roots thru grater
spinning wheel to grate manioc
toasting *farinha*
kneading manioc mash
toss/remove *farinha* from griddle
wash manioc roots
tightening the press
fill tipiti / sacks
feed fire
sifting manioc / *farinha*
cut wood with ax
cut wood with machete
remove *açai* from stem
pour water over *açai*
massando açai (*peneira grosa*)
massando açai (*peneira fina*)
mixing *açai* juice
fill buckets with *açai*
pound *açai* with bottle
holding peneira
paddle canoe
remove water from canoe
shucking beans

feeding animals
sharpen knife
pounding mortar/pestle
tending raised garden
remove manioc stems

Far from the house/Garden Work
fishing with line
collecting worms/shrimp
weeding
pulling up manioc
cutting root ends with machete
filling baskets with manioc
carrying manioc basket
planting manioc
digging holes / hoeing
gather wood
climbing tree to collect *açai*
gathering branches to clear land

Infant Care
hold baby
carrying baby
taking care of baby
playing with baby

Breastfeeding
breastfeeding

Breastfeeding Structure

In addition to calculating the total time spent breastfeeding, other aspects of breastfeeding structure were collected/calculated.

Number of Bouts. A breastfeeding bout is defined as the time from the moment the baby's mouth touched the breast until the moment it was pulled away. Breastfeeding bouts that were less than one minute apart were combined. An average number of bouts was calculated for each

woman by adding the total number of bouts over the three-day period and then dividing the total by three. These means were combined to calculate the group mean.

Bout length. Bout length (minutes), defined as the time the infant latched onto the breast until the time the infant pulled its mouth away, was calculated to the nearest second for each breastfeeding bout. Averages were calculated for each woman on each day of observation and these values were combined to calculate the group mean in each of the measurement rounds.

Inter-bout Interval. The mean interval between bouts (minutes) was calculated by subtracting the stop time of one bout from the start time of the next breastfeeding bout. Mean bout length was calculated for each woman each day and then used to calculate the mean per measurement round, as described above. After calculating the mean interval between bouts for each woman each day, these means were combined and used to calculate the overall group mean in each measurement round.

Total Time Spent Breastfeeding. The total time spent breastfeeding was calculated by adding together the length (in minutes) of all breastfeeding bouts for each woman for each day. These numbers were then used to calculate the mean for each woman and for the group as a whole in each of the three measurement rounds. Percent time spent breastfeeding was calculated by dividing the total time breastfeeding by the total observed period (8AM -5PM, total of 540 minutes).

High vs. Low Subsistence work. Once the mean of the total time spent doing subsistence activities during the observation period was determined, along with the mean of the total time spent processing manioc and doing garden work per day, the women were divided in to two groups: high subsistence work and low subsistence work. Women with individual mean total times for a measurement round that were greater than the mean total times for all women were placed in the "high subsistence work" category. Women with mean total times for a measurement round that were less than the mean total times for all women in that round were placed in the "low subsistence work" category. After determining the high and low categories for all subsistence activities, the women were also placed in high and low categories for individual mean total time in manioc processing and individual mean total time in garden work.

Data Analysis

Descriptive statistics (mean, standard deviation (SD), coefficient of variation (CV) (SD/AVG X 100), range, and percentages) are used to describe the breastfeeding structure (number of bouts, length of bouts, and the interval between bouts), time spent breastfeeding, time in infant care, and time in subsistence work (both garden and processing) in each of the three measurement rounds. To identify changes in breastfeeding structure over the course of lactation, Hotelling's T^2 test was used.

To test the hypothesis that subsistence work was negatively correlated with time spent breastfeeding and in infant care, Pearson's correlations were used. Pearson's correlations were also used to look at the impact of subsistence work on breastfeeding structure (number of bouts, length of bouts, and the interval between bouts). In addition, independent sample Student's T-tests were used to compare total time in breastfeeding and infant care, as well as breastfeeding

structure between women classified as participating in high amounts of subsistence work and those classified as having low levels of subsistence work. SPSS Version 16 was used for all statistical analysis. Significance is defined as alpha ≤ 0.05.

RESULTS

Reproductive Characteristics

Table 2 reports the reproductive characteristics of the women involved in this study.

TABLE 2. Reproductive Characteristics of the Women Involved in this Study

average age of the women	average age at menarche	average age at birth of the first child	average parity	average breastfeeding duration with the observed infant	average resumption of menstruation	average inter-birth interval
27.6 ± 9.1 years	12.8 ± 0.9 years	17.3 ± 1.7 years	5.6 ± 3.9	18.2 ± 5.7 months	11.9 ± 6.9 months	27.2 ± 12.1 months

Breastfeeding Structure

Time spent breastfeeding

Table 3 reports the total time during the observation period (8:00 AM – 5:00 PM) spent breastfeeding in the three measurement rounds. Figure 2 also reports the variation in the time total spent breastfeeding and the mean for each measurement round. The women were observed for a total of 540 minutes each day. In terms of total time, the women breastfed their infants the most during *resguardo* (mean 75.1 ± 35.4 min/day), and the least during late lactation (mean 38.5 ± 16.4 min/day). Peak lactation (mean 65.9 ± 31.3 min/day) showed the greatest variation in the time spent breastfeeding (CV 47.6%) and late lactation showed the least variation (CV 42.7%) (Figure 2). While there was little change in the total time spent breastfeeding each day

from *resguardo* to peak (-9.2 min/day), there was a more significant decrease in the total time spent breastfeeding from peak to late lactation (-27.4 min/day).

TABLE 3. Total time spent breastfeeding (minutes)

Period	Mean	SD	CV	Minimum	Maximum	% of the total observed time
Resguardo	75.1	35.4	47.2	32.5	149.0	14.23
Peak	65.9	31.3	47.6	31.7	157.0	12.46
Late	38.5	16.4	42.7	0.0	68.7	7.24

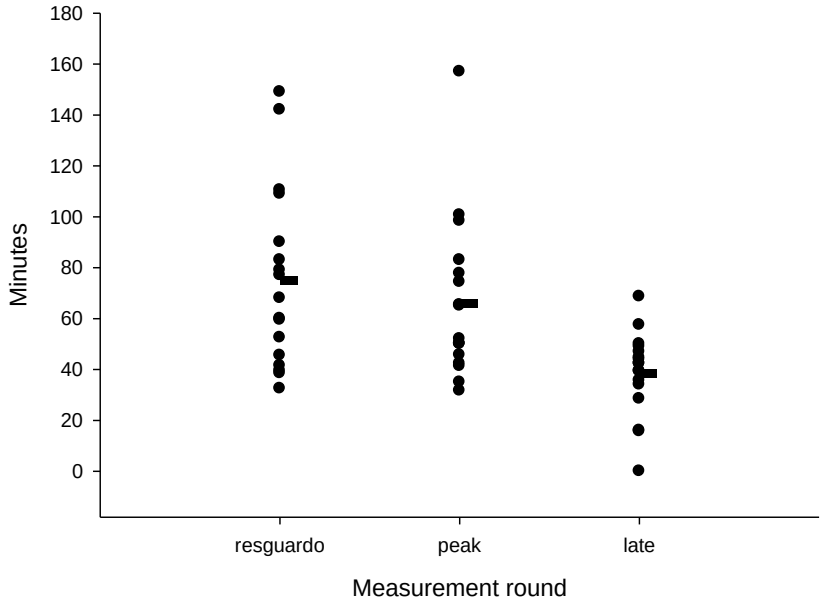

FIGURE 2. The total time each woman spent breastfeeding (minutes) during the observation period. (Note: the dash represents the group mean)

Number of bouts.

Table 4 reports the mean number of breastfeeding bouts in the three measurement rounds. Figure 3 shows the variation in the number of bouts in each round. The women breastfed their

infants the highest number of times per day during *resguardo* (mean 10.5 ± 3.0 bouts/day) and the fewest number of times per day during peak lactation (mean 9.4 ± 3.4 bouts/day). Late lactation (mean 10.2 ± 5.0 bouts/day) showed the greatest variation in number of bouts (CV 49.0%) and *resguardo* showed the least variation (CV 28.6%) (Figure 3). There was little change in the number of bouts over time, with a slight decrease from *resguardo* to peak lactation (-1.1 bouts/day) and a slight increase from peak lactation to late lactation (+0.8 bouts/day).

TABLE 4. Mean number of bouts

Period	Mean	SD	CV	Minimum	Maximum
Resguardo	10.5	3.0	28.6	5.5	17.5
Peak	9.4	3.4	36.2	4.3	16.0
Late	10.2	5.0	49.0	4.0	20.0

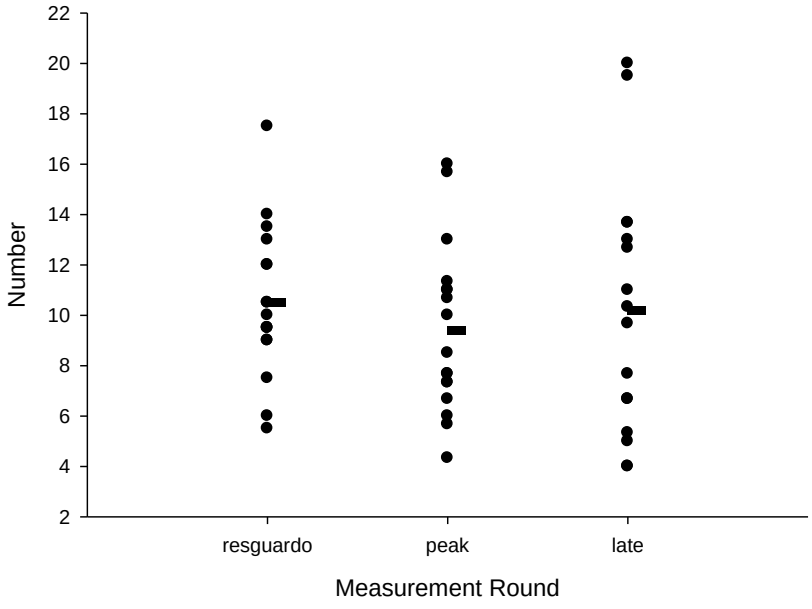

FIGURE 3. The total number of bouts per day during the observation period for each woman. The dash represents the mean. (Note: the dash represents the group mean)

*Length of bouts***.**

Table 5 reports the mean length of breastfeeding bouts in the three measurement rounds. Figure 4 shows the variation in the length of bouts. The longest bout lengths were observed during *resguardo* (mean 7.2 ± 2.9 minutes) and the shortest during late lactation (mean 4.4 ± 1.1 minutes). Bout length was most variable during *resguardo* (CV 40.4 %) and least variable during late lactation (CV 25.7 %) (Figure 4). There was no change in the length if bouts from *resguardo* to peak lactation. However, there was a more noticeable decrease in bout length between peak lactation to late lactation (-2.7 minutes per bout).

TABLE 5. Mean length of bouts (minutes)

Period	Mean	SD	CV	Minimum	Maximum
Resguardo	7.2	2.9	40.4	3.9	14.4
Peak	7.1	1.9	26.2	4.2	10.2
Late	4.4	1.1	25.7	3.0	6.7

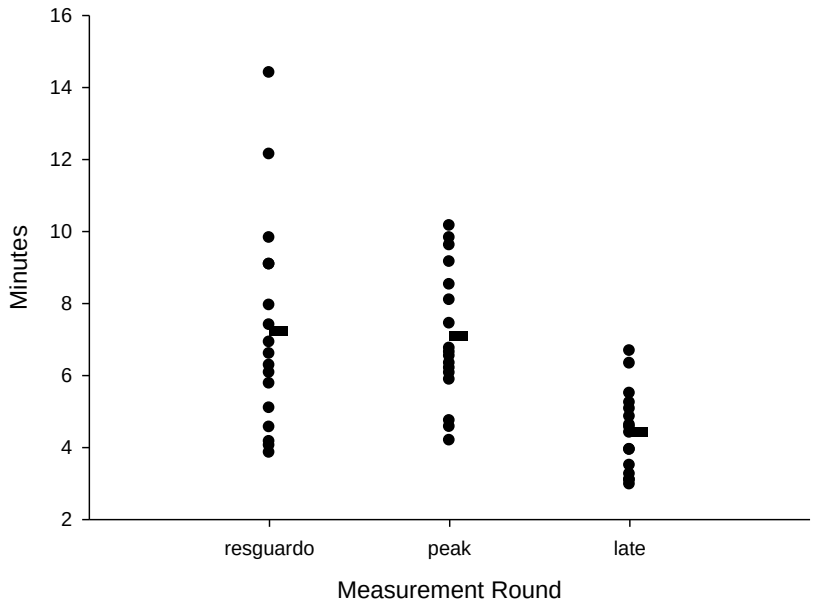

FIGURE 4. The mean length of bouts during the observation period for each woman. (Note: the dash represents the group mean)

Interval between bouts.

Table 6 reports the mean interval between breastfeeding bouts in the three measurement rounds. Figure 5 shows the variation in the mean interval between bouts. The interval between breastfeeding bouts was the longest during late lactation (mean 57.8 ± 33.9 minutes) and the shortest during *resguardo* (mean 44.7 ± 12.8 minutes). Variation in inter-bout interval was greatest during late lactation (CV 58.6 %) and least during r*esguardo* (CV 28.6 %) (Figure 5). The interval between bouts increased from *resguardo* to peak lactation (+8.9 minutes) and again from peak lactation to late lactation (+4.2 minutes).

TABLE 6. Mean interval between bouts (in minutes)

Period	**Mean**	**SD**	**CV**	**Minimum**	**Maximum**
Resguardo	44.7	12.8	28.6	25.9	72.5
Peak	53.6	21.9	40.9	24.7	110.8
Late	57.8	33.9	58.6	18.2	154.2

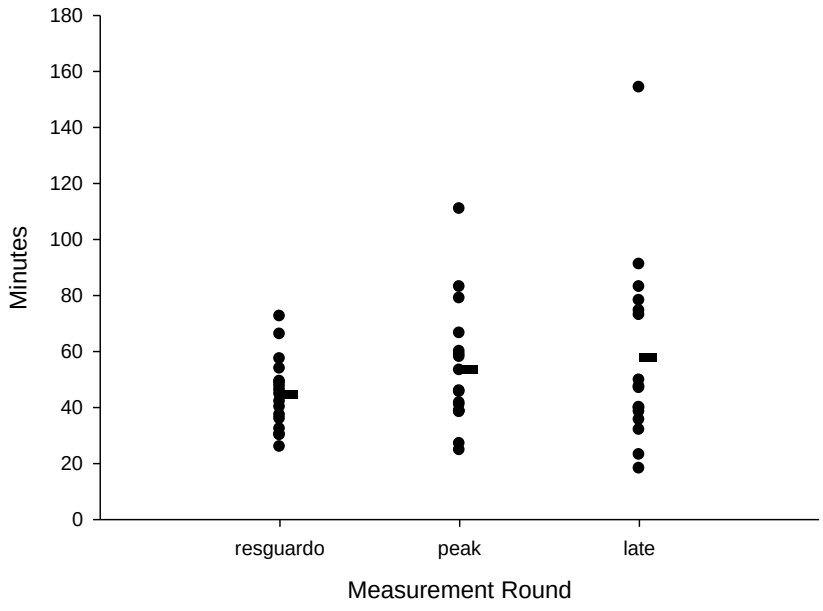

FIGURE 5. The mean interval (minutes) between bouts during the observation period for each woman. (Note: the dash represents the group mean)

Change in breastfeeding structure over time

In order to determine if there was a significant change over time in breastfeeding structure, a Hotelling's T^2 test was used. The length of the bouts ($T^2 = 44.29$, $p<0.05$) showed significant change over time. However, the number of bouts ($T^2 = 1.15$, $p>0.05$) and the interval between bouts ($T^2 = 3.58$, $p>0.05$) did not show significant change over time.

Infant Care

Table 7 reports the total time during the observation period spent in infant care activities, excluding breastfeeding, in the three measurement rounds. Figure 6 shows the variation in the total time spent caring for the infant. The women spent the most time in infant care during *resguardo* (mean 153.4 ± 53.2 min/day) and the least amount of time per day in infant care during late lactation (76.0 ± 32.5 min/day). The average time spent in infant care was most variable during late lactation (CV 42.7 %) and the least variable during peak lactation (CV 30.0 %). There was a decrease in time spent in infant care per day from *resguardo* to peak (-30.9 min/day) and from peak to late lactation (-46.5 min/day).

TABLE 7. Total time spent in infant care (minutes)

Period	Mean	SD	CV	Minimum	Maximum	% of the total observed time
Resguardo	153.4	53.2	34.7	39.0	284.0	29.06
Peak	122.5	36.7	30.0	70.2	206.2	23.18
Late	76.0	32.5	42.7	17.6	126.7	14.31

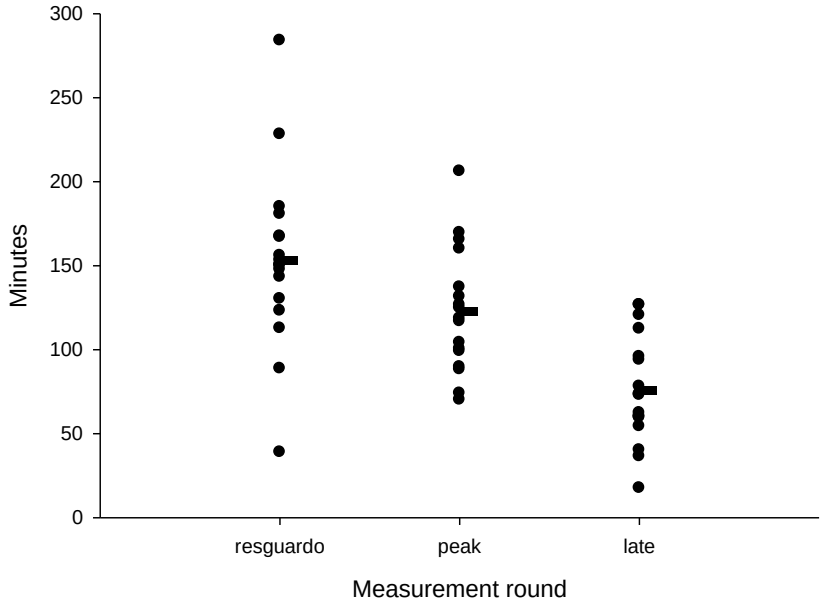

FIGURE 6. The total time each woman spent caring for her infant (minutes) during the observation period. (Note: the dash represents the group mean)

Subsistence Work

In order to determine the influence of subsistence work on breastfeeding and infant care, the total time spent in subsistence work was calculated. Table 8 reports the total time during the observation period spent in subsistence activities in the three measurement rounds. In order to determine if the location of the subsistence activity affected breastfeeding patterns and infant care, the subsistence activities were separated in to two categories: manioc processing (close to the home) and garden work (far from the home in the manioc gardens). Figure 7a shows the variation in the total time spent doing subsistence work. Figure 7b shows this data for the total time spent processing manioc while Figure 7c shows the data for time spent doing garden work. The women participated in subsistence work the greatest amount of time per day during late lactation (mean 100.6 ± 78.1 min/day), and the least amount of time during *resguardo* when

none of the women conducted any subsistence tasks as they were prohibited during this restricted period. There was an increase in the total time spent in subsistence work each day from *resguardo* to peak (+43.9 min/day) and from peak to late lactation (+56.7 min/day). The greatest variation in the total time spent in subsistence work was during peak lactation (CV 116.7 %).

The women spent the greatest amount of time processing manioc per day during late lactation (83.2 ± 66.7 min/day), and did not do any manioc processing during *resguardo*. There was an increase in the total time spent processing manioc from *resguardo* to peak (+35.2 min/day), and from peak to late lactation (+48.0 min/day). The total time spent processing manioc showed the greatest variation during peak lactation (CV 120.2%).

The women spent the greatest amount of time per day doing garden work during late lactation (17.5 ± 22.0 min/day), and did not participate in any garden work during *resguardo*. There was an increase in the total time spent doing garden work from *resguardo* to peak (+17.5 min/day), and from peak to late lactation (+8.9 min/day). The total time spent doing garden work showed the greatest variation during late lactation (CV 167.0 %).

The women spent more time processing manioc (peak = 6.7%, late = 15.7% of the observed time) than doing garden work (peak = 1.6%, late = 3.3% of the observed time) during both peak and late lactation. The total time spent in both manioc processing and garden work increased over the course of lactation.

TABLE 8. Total time spent in subsistence work (minutes)

Period	Type of Work	Mean	SD	CV	Minimum	Maximum	% of the total observed time
resguardo							
	processing	0	0	0	0	0.00	0.00
	garden	0	0	0	0	0.00	0.00
	total	0	0	0	0	0.00	0.00
peak lactation	processing	35.2	42.4	120.2	2.8	164.33	6.67
	garden	8.6	14.4	167.0	0.0	40.89	1.63
	total	43.9	51.2	116.7	2.8	180.83	8.30
late lactation	processing	83.2	66.7	80.2	4.2	217.94	15.66
	garden	17.5	22.0	126.3	0.0	69.33	3.29
	total	100.6	78.1	77.6	4.2	233.06	18.95

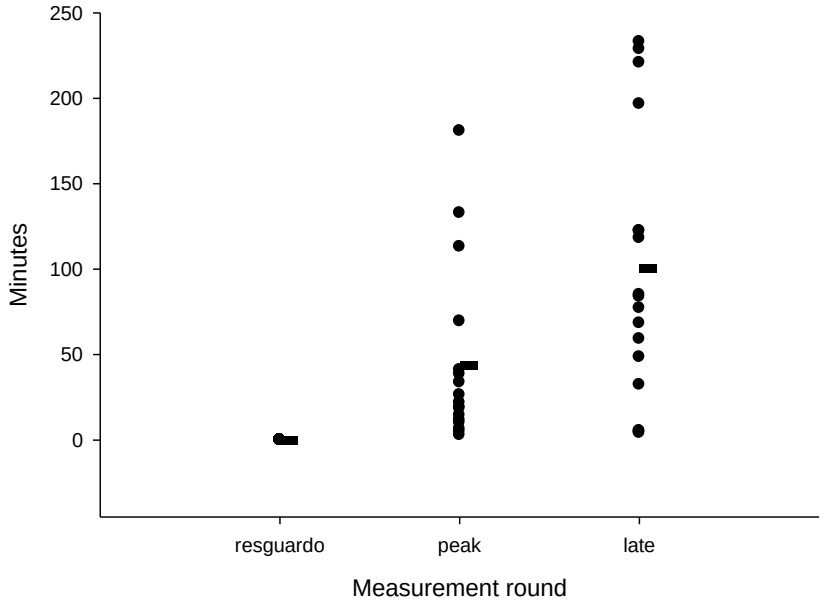

FIGURE 7a. The total time each woman spent in subsistence work (minutes) during the observation period. The dash represents the mean. (Note: the dash represents the group mean)

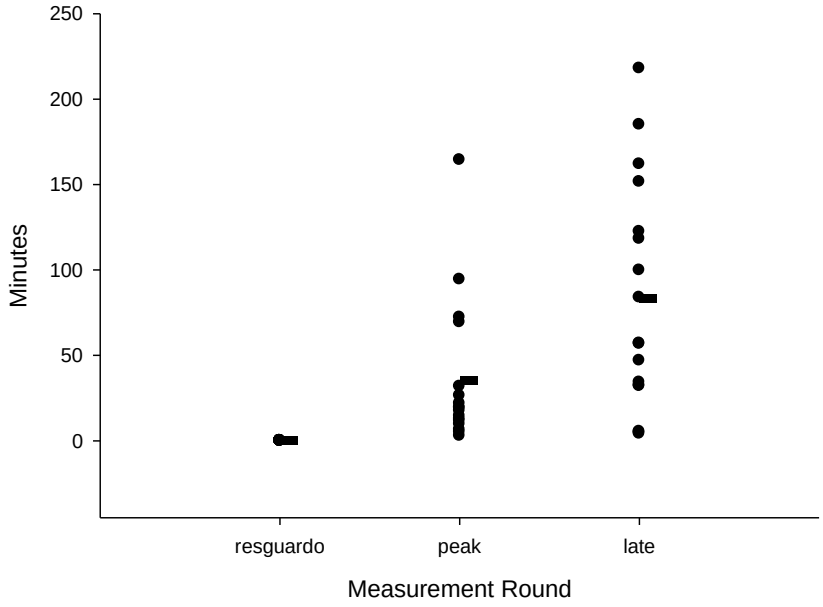

FIGURE 7b. The total time each woman spent in manioc processing during the observation period. The dash represents the mean. (Note: the dash represents the group mean)

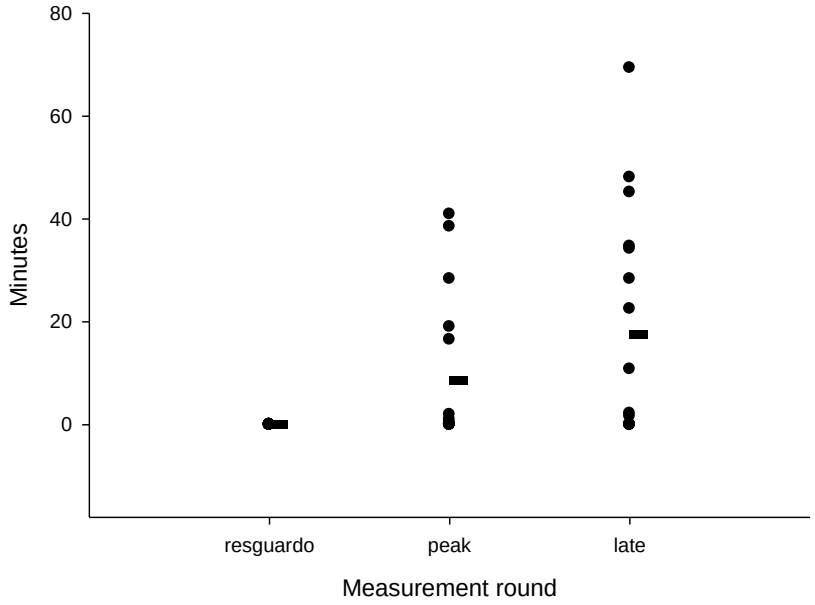

FIGURE 7c. The total time each woman spent working in the garden (minutes) during the observation period. The dash represents the mean. (Note: the dash represents the group mean)

Maternal work, breastfeeding, and infant care

In order to determine if total time in subsistence work was negatively associated with the time spent in infant care, including breastfeeding, bivariate correlations and independent-sample t-tests were used. Table 9a reports some of the correlations for peak lactation and Table 9b reports some of the correlations for late lactation. There were no significant correlations between the total time spent breastfeeding and the following variables: total time spent in subsistence work, total time spent processing manioc, or total time spent doing garden work during either peak or late lactation. No significant correlations were found between the number of bouts or the length of bouts and the total time spent in subsistence work, the total time spent processing manioc, or the total time spent doing garden work during either peak or late lactation. There was no correlation between the interval between bouts and any of the subsistence activities during peak lactation. However, the interval between bouts was positively correlated with garden work during late lactation ($r = 0.60$, $p = 0.01$). Infant care was also not correlated with any of the subsistence activities during peak lactation, but was negatively correlated with the total time spent in subsistence work ($r = - 0.56$; $p = 0.02$) and the total time spent in manioc processing ($r = -0.61$; $p = 0.01$).

Table 10 compares the women with high subsistence work to the women with low subsistence work in terms of breastfeeding structure and infant care. There were no significant differences between the two groups in terms of breastfeeding structure (number of bouts, length of bouts, interval between bouts, total time spent breastfeeding) in either round. However, there was a significant difference between the two groups in terms of infant care ($t = 2.14$; $p = 0.05$). Women who spent more time in subsistence tasks spent significantly less time in infant care during peak lactation.

TABLE 9a. Correlation between subsistence work and total time spent breastfeeding and in infant care during peak lactation.

	Total time spent breastfeeding	Total time spent in infant care (not including breastfeeding)	Total time spent in subsistence work	Total time spent in manioc processing	Total time spent in garden work
Total time spent breastfeeding	1.00	-0.80	-0.24	-0.25	-0.13
Total time spent in infant care	-0.80	1.00	-0.46	-0.44	-0.34
Total time spent in subsistence work	-0.24	-0.46	1.00	0.97**	0.70
Total time spent in manioc processing	-0.25	-0.44	0.97**	1.00	0.51*
Total time spent in garden work	-0.13	-0.34	0.70	0.51*	1.00

***Correlation is significant at the 0.01 level*

**Correlation is significant at the 0.05 level*

TABLE 9b. Correlation between subsistence work and total time spent breastfeeding and in infant care during late lactation.

	Total time spent breastfeeding	Interval between bouts	Total time spent in infant care (not including breastfeeding)	Total time spent in subsistence work	Total time spent in manioc processing	Total time spent in garden work
Total time spent breastfeeding	1.00	-0.72**	0.39	-0.32	-0.23	-0.44
Interval between bouts	-0.72**	1.00	-0.21	0.45	0.34	0.60**
Total time spent in infant care	0.39	-0.21	1.00	-0.56*	-0.61**	-0.13
Total time spent in subsistence work	-0.32	0.45	-0.56*	1.00	0.97**	0.621**
Total time spent in manioc processing	-0.23	0.34	-0.61**	0.97**	1.00	0.40
Total time spent in garden work	-0.44	0.60**	-0.13	0.621**	0.40	1.00

***Correlation is significant at the 0.01 level*

**Correlation is significant at the 0.05 level*

Table 10. Comparison of breastfeeding patterns and infant care during the observation period (~540 minutes) between women with high vs. low time spent in subsistence work

		n for peak	mean for peak	t-test for peak	n for late	mean for late	t-test for late
Total time spent breastfeeding (minutes)	High	13	57.00		7	35.81	
	Low	4	68.60	t= 0.64, p= 0.54	10	40.33	t= 0.55, p= 0.59
Number of bouts							
	High	13	9.42		7	9.17	
	Low	4	9.40	t= -0.01, p= 0.99	10	10.96	t= 0.70, p= 0.50
Length of bouts (minutes)	High	13	5.95		7	4.31	
	Low	4	7.45	t= 1.46, p= 0.17	10	4.54	t= 0.39, p= 0.70
Interval between bouts (minutes)	High	13	50.79		7	67.24	
	Low	4	54.40	t= 0.28, p= 0.78	10	50.44	t= -0.98, p= 0.34
Total time spent in infant care (minutes)	High	13	95.60		7	57.79	
	Low	4	130.80	t= 1.79. p= 0.09	10	88.74	t= 2.14, p= 0.05

Discussion

While breastfeeding has been shown to have positive health effects for both infants and mothers, breast milk production and infant feeding are costly in terms of both energy and time to the mother. Therefore, the benefits of breastfeeding to the infant must be balanced with the costs to the mother. In this rural setting where women play a significant role in food production, women must find strategies to accommodate their roles as both producers and reproducers.

While Brown (1970) suggested that female subsistence strategies are often compatible with childcare, Nerlove (1974) noted women still only have a limited amount of time to accomplish all of their tasks and in her study found that women contributing more to subsistence activities started supplementary feeding earlier. Other studies have examined the relationship between subsistence work and breastfeeding frequency (Gray, 1995) and child nutrition and women's work (Panter-Brick, 1992; Wandel and Holmboe-Ottesen, 1992). The possible influence of breastfeeding on the efficiency of subsistence work has also been discussed in several studies (Meldrum and Di Domenico, 1982; Hurtado et al., 1985; Lado, 1992).

While the challenge to look beyond breastfeeding duration and examine breastfeeding patterns has been met by a few researchers (Vitzthum 1994; Marriott 1998), none have examined these patterns among a tropical horticulturalist group. In order to examine a possible conflict between infant care and subsistence work, I first examined the breastfeeding structure and total time spent in breastfeeding, caring for the infant, and subsistence work. I then examined the relationship between breastfeeding/infant care and subsistence work.

Breastfeeding patterns and change over time

The first hypothesis (H1) was that the number of bouts and length of bouts would decline over time and the interval between bouts would increase as lactation progresses. However, the breastfeeding patterns showed little change over time. The number of bouts showed no significant change over time. The length of bout significantly ($p<0.05$) decreased over time. This is supported by other studies that found a negative correlation between infant age and bout length or session duration (Marriott, 1998) and the duration of breastfeeding bouts during the morning (Vitzthum, 1989). However, Konner and Worthman (1980) did not find a significant relationship between infant age and bout length or the time spent nursing in their study among the !Kung. In this study of *Ribeirinha* women, the bout lengths may have decreased due to the introduction of supplemental foods. While the infants may have fed the same number of times, the length of each bout decreased as the infant was given additional nutrition.

In terms of inter-bout intervals, Konner and Worthman (1980) found a significant relationship between the infant's age and the interval between bouts. Panter-Brick (1994) also found that the interval between bouts increased with a child's age among the Tamang, but not the Kami, of Nepal. She examined child nutrition and women's work in two different castes in Nepal during different seasons. The first group, the Tamang, are agropastoralists whose subsistence work varied seasonally. The second group, the Kami, were blacksmiths who had lower levels of subsistence work and spent more time at home than the Tamang. Panter-Brick found that among the Tamang, who would bring children under three years of age to the fields with them, the interval between bouts increased with the child's age. Among the Kami, the interval between bouts did not vary with the child's age as these women spent more time at home. This was not the case among the *Ribeirinha* women in this study as the inter-bout interval did not show a

significant decrease over time. However, the infants in this study were no older than ~16 months, which could indicate they were not old enough to see significant change in breastfeeding patterns. Finally, Gray (1995) in her found that breastfeeding episodes (nursing events separated by less than 5 seconds) only lasted 2 to 3 minutes in her study of the breastfeeding patterns among the Turkana compared to the shorter mean length of bouts (means ranging from 4.4 to 7.2 minutes) in this study.

In this study of the *Ribeirinha*, both the total time (during the observation period) spent breastfeeding and caring for the infant decreased over time. The time spent doing subsistence work increased over time, with none of the women doing subsistence work during *resguardo*. The women spent more time processing manioc than garden work, but both types of subsistence work increased over time.

Relationship between time spent in subsistence work vs. time spent breastfeeding and caring for the infant

The second hypothesis (H2) was that the total time in subsistence work would be negatively correlated with time spent in infant care, including breastfeeding. There were no correlations between breastfeeding structure (number of bouts, bout length, interval between bouts, total time spent breastfeeding) and the total time spent in subsistence work, the total time spent processing manioc, or the total time spent working in the garden during peak lactation. The only aspect of breastfeeding structure that was significantly correlated with subsistence work was inter-bout interval during late lactation ($r = 0.60$, $p = 0.01$). Overall, this data does not support the second hypothesis.

One of the reasons breastfeeding structure is not influenced by increased subsistence work could be the type of work these women do. Primarily focusing on processing manioc, this group of women did very little garden work. The women spent much more time processing manioc (peak = 6.7%, late = 15.7% of the observed time) than doing garden work (peak = 1.6%, late = 3.3% of the observed time). The manioc processing huts were usually right next to the home, while the gardens were farther away. This meant the women were spending much more time near the home rather than far away from it. The fact that breastfeeding structure was not influenced by subsistence work and that the women spent most of their time processing manioc brings up an important question: are processing activities more compatible with breastfeeding?

Brown's (1970) study concluded that in order for women's subsistence work to be compatible with childcare, the work will be close to the home, repetitive, interruptible, and not dangerous. Manioc processing meets these criteria in this study of *Ribeirinha* women. The close proximity of the processing huts to the home could allow these women to breastfeed the infants while they were working. Therefore, the time spent breastfeeding would not be affected by subsistence work. Even if another person was caring for the infant while the mother was working, the infant could easily be taken over to the mother for breastfeeding. This coincides with observations during the study that indicated that infants were often brought from the home to the mother in the processing hut for breastfeeding. Manioc processing is also quite repetitive, several of the steps can be stopped (with the exception of toasting the manioc) to care for an infant, and the processing hut is a safe environment. The fact that there was no significant difference in the time spent breastfeeding between the women with high subsistence work and the women with low subsistence work demonstrates the compatibility of this type of subsistence work with breastfeeding.

As mentioned above, women spent very little time working in the garden. This could be due to the fact that garden work was not compatible with infant care. Women in this region often left their infants at home while they worked in their *roças* (manioc gardens), as the *roças* were considered dangerous for the infant due to sun exposure and insects. The interval between bouts during late lactation was the only breastfeeding variable to be significantly correlated ($r = 0.60$, $p = 0.01$) with garden work. When working in the *roças,* a mother would be separated from the infant for a longer period of time. The increase in the interval between bouts with an increase in the time spent doing garden work could be due to this prolonged separation. Since the women spent so little time doing garden work, the time spent doing garden work did not significantly influence the overall breastfeeding structure.

Several other studies have noted the tendency of women to engage in subsistence activities that are more compatible with childcare. Hurtado et al. (1985) noted that women appeared to engaged in subsistence strategies that were compatible with infant care in their study of the Ache. They noted Ache women had their infants with them almost all the time, including while they gathered food. Hurtado et al. (1985) noted that the women tended to exploit resources with lower caloric content because they were easier to collect while carrying the infants. Goodman et al. (1985) noted one possible factor allowing Agta women to hunt, despite their childcare responsibilities, was the close proximity of the hunting areas to the camps.

In a time allocation study, Panter-Brick (1994) determined that the subsistence work of the Tamang did not appear to influence the time they spent breastfeeding children under three years of age. Total time spent breastfeeding did not change over the course of the year, despite the fact that the amount of time dedicated to subsistence work doubled during the monsoon

season. This is similar to what I found among the *Ribeirinha* women. The amount of time women spent in subsistence work did not affect the time they spent breastfeeding their infants.

Other studies have found that high levels of subsistence work had a negative effect on the number of times an infant was fed. While the women might not be able to feed their infants as often, they find other coping mechanisms to ensure the infant receives proper nutrition. Wandel and Holmboe-Ottesen (1992) studied the effect of women's involvement in food production on the nutritional status of their children in Tanzania. They found that while children are fed less often during the peak labor season, there was not a significant negative correlation between a mother's agricultural work and the child's nutrition. These women often brought their children with them to the fields, which was not the case in the study in the Amazon. The findings of Wandel and Holmboe-Ottesen (1992) do not support this study as there was no significant correlation between high subsistence work and breastfeeding.

Another factor that could allow for the breastfeeding patterns to remain unchanged despite an increase in subsistence work could be a decrease in infant care. Table 1 defines infant care activities, which involve holding or playing with the infant when they are not being breastfed. There was a significant negative correlation between the total time spent in infant care and the total time spent in subsistence work ($r = - 0.56$; $p = 0.02$) and the total time spent in manioc processing ($r = -0.61$; $p = 0.01$). The women may still be able to maintain the time spent breastfeeding the infant despite increased workloads by decreasing the amount of time spent in other infant care activities. Social support is another coping strategy that women use to aid with either infant care, subsistence work, or both. Mothers could breastfeed the infant and then have an older daughter or grandmother care for the infant while they did subsistence work. The t-test showed a significant difference in total time spent in infant care between women with high

subsistence work and women with low subsistence working during late lactation ($t = 2.14$; $p = 0.05$). This further indicates infant care was sacrificed with increasing subsistence work. While the nutrition of the infant did not appear to be affected by an increase in maternal subsistence work, the loss of the interaction with the mother due to decreased infant care could have other health implications.

Limitations of the study

This study was the first to incorporate longitudinal data when examining breastfeeding structure. The constraints of collecting detailed data meant the the sample size was small ($n = 17$). There was a high degree of variation, especially for subsistence work, which could possibly be due to the small sample size. The coefficient of variation for the total time spent in subsistence work was 116.7% for peak lactation and 77.6% for late lactation. The total time spent breastfeeding also spent varied from 42.7% to 47.6% for the coefficient of variation. This high degree of variation could make it difficult to determine breastfeeding and subsistence patterns, as well as the relationship between the two. Marriott (1998) also noted a great deal of individual variation in her study.

Future studies

This study has several implications for future studies. Vitzthum (1994) noted that women of similar breastfeeding magnitude showed much variation in post-partum amenorrhea. She noted the importance of going beyond the breastfeeding duration data and examining breastfeeding structure as a possible explanation of the variation in post-partum amenorrhea. A study of this nature, combined with hormonal data, could provide a better understanding of the factors that influence post-partum amenorrhea.

Conclusion

There was little change in the breastfeeding structure over time. Only the length of the bouts significantly decreased, indicating the overall pattern of breastfeeding was fairly steady over time. Overall, breastfeeding structure did not seem to be influenced by subsistence work. Since the women primarily focused on manioc processing, this seems to indicate that this type of work is less interfering with breastfeeding. The characteristics of manioc processing (being close to the home, repetitive, interruptible, not dangerous) seem to be compatible with breastfeeding. However, there was a significant negative correlation between infant care and total time spent in subsistence work. Decreasing the time spent caring for the infant (other than breastfeeding) and engaging in subsistence activities that are compatible with breastfeeding could allow these women to diminish the interference of subsistence work on breastfeeding. However, this decreased maternal care of the infant could have other health implications that would require further study.

Due to the gap in knowledge of the breastfeeding patterns in horticultural societies, this research can help us better understand how women in this setting accommodate their dual roles and the decisions they make regarding breastfeeding and subsistence work. Understanding the decisions these women made regarding the balance of infant care and subsistence work can provide valuable information that can inform public health policies and programs aimed at improving infant and maternal health in the developing world.

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